Risk Registry

- A “risk” is an event that has the potential to cause an unwanted change in the project.
- When identifying a risk, it should be stated clearly in terms of both the risk event and the consequences to the project.
- The format for the risk identified should be cause/risk/effect.
- A risk trigger is an event that indicates that a risk may be about to occur
- The trigger is then assigned a date to allow to monitor the trigger.
- After the risk mitigation approach is identified and a decision made to implement the mitigation, the mitigation cost becomes part of the line item cost and not the contingency.
- Only the remaining residual risk should be included in the risk register and contingency analysis.

The sPHENIX WBS Level 2 managers are responsible for:

- Identifying potential risks to the technical, cost, and schedule success of their WBS system, determining the likelihood of occurring, and estimating the potential impact on the project. This risk analysis is performed down to the deliverable level, usually WBS Level 3 or 4.
- Developing and executing risk abatement strategies for their Level 2 system.
- Informing the PM about the significant risks and the status of risk abatement strategies.
- Serving as members of sPHENIX RMB.

Project Risk	Significant risks
Facilities and Equipment	Major equipment development. Inadequate planning for long lead items and vendor support.
Design	Design relies on immature technologies or "exotic" materials to achieve performance objectives. Design not cost effective.
Requirements	Operational requirements not properly established or vaguely stated. Requirements are not stable. Requirements are too restrictive – cost risk.
Testing/ Evaluation/ Simulation	Test planning not initiated early in program (initiation phase). Testing does not address the ultimate operating environment. Test procedures don't address all major performance and suitability specifications. Facilities not available to accomplish specific tests, especially system-level tests. Insufficient time to test thoroughly. Project lacks proper tools and modeling and simulation capability to assess alternatives.
Schedule	Funding profile not stable from budget cycle to budget cycle. Schedule does not reflect realistic acquisition planning. Schedule objectives not realistic and attainable. Resources not available to meet schedule.
Supplier Capabilities	Inadequate supportability late in development, resulting in need for engineering changes, increased costs, and/or schedule delays. Restricted number of available vendors. Restricted production capacity.
Cost	Realistic cost objectives not established early. Funding profile does not match acquisition strategy.
Technology	Project depends on unproven technology for success with no alternatives. Project success depends on achieving advances in state-of-the-art technology. Potential advances in technology will result in less than optimal cost-effective system or make system components obsolete. Technology has not been demonstrated in required operating environment. Technology relies on complex hardware, software, or integration design.

Table 3: Impact Assessment Matrix for Project-Level Global Risks

Impact Risk Area	Low	Moderate	High
Cost:	≤ $250K	≤$500K	>$500K
Schedule:	Delays Level 2 milestone or Project critical path by ≤3 month	Delays Level 2 milestone or Project critical path by ≤6 months	Delays Level 2 milestone or Project critical path by >6 months
Scope/Technical:	Negligible, if any, degradation.	Significant technical/scope degradation.	Baseline scope or performance requirements will not be achieved.

Table 6: Risk Classification Matrix

	Impact		
Probability	**Low**	**Moderate**	**High**
High (probability > 75%)	Moderate	High	High
Moderate (25% < probability < 75%)	Low	Moderate	High
Low (probability < 25%)	Low	Low	Moderate

Risk Category			
Project Impact	High	Moderate	Low
Cost	Closely monitor cost and spending. Consider implementing phased procurements. Obtain multiple bottoms-up independent cost estimates Perform Value Engineering Visit Vendor.	Closely monitor cost and spending. Obtain at least two bottoms-up independent cost estimates.	Quality controls applied as defined in the BNL Quality Management Plan.
Schedule	Increase lead time substantially by initiating procurements 6 - 8 weeks early. Visit Vendor. Evaluate in-house procurement. Contract incentives and/or penalties. Maintain vendor oversight.	Increase lead time by initiating procurements 2 - 4 weeks early. Visit Vendor. Evaluate in-house procurement. Contract incentives and/or penalties. Maintain vendor oversight. Add additional vendors.	Quality controls applied as defined in the BNL Quality Management Plan.
Performance	Perform major redesign. Increase prototype cycles. Evaluate alternate technology. Request additional process control steps during fabrication. Define extensive QA and/or acceptance testing. Increase lead time and/or increase testing cycles.	Moderate redesign as required. Define QA and/or acceptance testing. Increase prototype acceptance tests.	Quality controls applied as defined in the BNL Quality Management Plan.

Owner	WBS	Risk Name	Risk trigger (if)	Consequences (then)	Timeframe	Probability	Impact	Rank	Mitigation Plan
E.O'Brien	1.1 Management	Departure of Key Personnel	Someone critical to the Project informs of his intention to	Schedule delay occurs	all	10%	Schedule: 3 months	Low	Closely work with sPHENIX collaboration to identify a potential replacement.
E.O'Brien	1.1 Management	Safety incident	Safety incident resulting in injury	Schedule delay occurs	all	5%	Schedule: 1 month	Low	Carefully plan all work in accordance with BNL SBMS. Include safety reviews and safety review recommendations implementation in sPHENIX resource loaded schedule.
E.O'Brien	1.1 Management	Funding profile stretches	Funds not available on time	Cost increases because procurements need to be broken down into smaller units, or existing quotes expire, or new	production	50%	Schedule: 12-24 months Cost: $500K	High	Work closely with the funding agency so any funding profile changes can be evaluated as early as possible and sPHENIX Project schedule optimally adjusted to match the new funding profile.
E.O'Brien	1.1 Management	Infrastructure support delayed	Infrastructure milestone is delayed	Project activities dependent on Infrastructure milestone are delayed	all	5%	Schedule: 2 months	Low	Develop a detailed resource loaded schedule with key milestones for Infrastructure support and closely monitor this schedule for risk triggers.
T. Hemmick	1.2 TPC	Procure v1a GEMs				Low	Low	Low	In case the proper GEMs for the v1a prototype are not in hand, an adapter plate will be requires to fit an existing GEM-stack to allow the magnet test to proceed.
T. Hemmick	1.2 TPC	Performance failure of v2 prototype				Low	Moderate	Moderate	We will add a design cycle of a smaller device than the full sized field cage if the v1 prototype fails. We will proceed on v2 only after success of the small version.
T. Hemmick	1.2 TPC	Failure or delay of CERN production				Low	High	Moderate	We will monitor carefully the success of CERN foil production and will hire a technician who will exclusively work on producing GEM foils for our project. If delays still occur, we will seek a second vendor (e.g. Tech Etch).
T. Hemmick	1.2 TPC	SAMPA Chip Failure				Low	High	Moderate	ALICE and STAR shall be forced to mitigate the situation and if not, alternatives such as the sALTRO and DREAM chips must be considered.
S. Stoll	1.3 EmCal	Loss of W powder supplier						Low	Find another source of W powder which can meet our specs. Some have already been investigated. Attempt to identify primary source of raw powder in China and identify new distributor.
S. Stoll	1.3 EmCal	Loss of SciFi supplier						Moderate	Two suppliers have been identified. We believe both can meet our specs, but one is roughly 2X high cost. If lower priced supplier cannot deliver then we must use contingency to purchase from other supplier.
S. Stoll	1.3 EmCal	Loss of primary production site for blocks (University of Illinois Urbana						Low	Blocks would have to be built at BNL. However, we would loose scientific oversight provided by UIUC, student labor, free use of facilities, space, etc.
S. Stoll	1.3 EmCal	Cannot find cost effective solution for making light guides						Moderate	We are investigating both injection molding and casting of light guides. Several companies have been identified. Injection molding has been shown to produce encouraging results but with low yield.
J. Lajoie	1.4 HCal	Loss of						Moder	Explore alternate scintillator vendors (FNAL,

									low yield.
J. Lajoie	1.4 HCal	Loss of scintillating tile provider (Uniplast)						Moderate	Explore alternate scintillator vendors (FNAL, Elgin).
J. Lajoie	1.4 HCal	Unable to produce inner HCAL in SS310 in a cost effective manner						Moderate	Investigate value-engineering designs and alternate materials (brass); will require re-engineering.
J. Lajoie	1.4 HCal	Unable to identify suitable BNL location for outer HCAL mechanical assembly						Low	Investigate assembly by commercial vendors.
J. Lajoie	1.4 HCal	Unable to identify suitable site(s) for inner HCAL assembly (scint. and electronics)						Low	Investigate possibility of assembly (scintillator and electronics) at BNL.
E. Mannel	1.5 Cal Electronics	Delay in SiPM Delivery		Delay in assembly of Hcal and EMCal SiPM daughter boards. Potential delay in Hcal and EMCal module assembly				Low	Closely monitor the procurement stage. Increase the rate of testing and assembly
E. Mannel	1.5 Cal Electronics	Delay in testing of SiPMs		Delay in assembly of Hcal and EMCal SiPM daughter boards. Potential delay in Hcal and EMCal module assembly				Moderate	Increase number of testing stations. Identify additional collaborators who can contribute to the testing program. Streamline testing program.
E. Mannel	1.5 Cal Electronics	Delay in Assembly of Hcal Daughter boards, Preamps, Interface boards, LED Drivers		Potential delay in HCal module assembly and testing				Low	Staged partial deliveries of boards. Use multiple assembly houses
E. Mannel	1.5 Cal Electronics	Delay in assemblly of EMCal Daughter boards, Preamps or Interface boards		Potential delay in EMCal module assembly and testing				Low	Staged partial deliveries of boards. Use multiple assembly houses
M. Purschke	1.6 DAQ/Trigger	DAQ Prototype		DAQ prototype throughput and performance is below specifications				Low	Acquire more expensize PCs / re-design parts of the architecture
M. Purschke	1.6 DAQ/Trigger	Network switch		Network switch more expensive than projected				Low	try to use "software" switch / cascading of cheaper, smaller switches
M. Purschke	1.6 DAQ/Trigger	Global Lvl1		adaptation of PHENIX GL1 runs into obstacles				Low	select different card, re-design parts of the architecture
M. Purschke	1.6 DAQ/Trigger	Timing System		Conversion/adaptation from GLINK problematic, or envisioned replacement board cannot be used				Low	select different card, re-design parts of the architecture
M. Purschke	1.6 DAQ/Trigger	Local LVL1		Performance of LLVL1 algoithms inaedequate. Trigger latency too high.				Moderate	prioritize Physics goals, procure more hardware
M. Purschke	1.6 DAQ/Trigger	Storage		Data volume, especially from the TPC, too high				Moderate	invest in more local storage, change compression algorithms
M. Chiu	1.7 MinBias	Acquire permission to use PHENIX BBC						Low	Use scintillator BBC or another alternative
M. Chiu	1.7 MinBias	Magnetic field capability of BBC PMTs						Low	Testing mesh dynode PMTs to remove uncertainty in B-field performance. Worst case, move BBC to z=±300 cm
M. Chiu	1.7 MinBias	Develop discriminator/shaper board						Low	Design and test it as early as possible (2017)
D. Lynch	Infra. Integr.	Subsystem not ready for						Moder	Build in adequate schedule contingency

P. Giannotti	1.9 Infrastructure	Cradle Fabrication delayed	Supplier reports cannot meet schedule	Detector Installation Delayed	Production	Low	Moderate	Low	Reliable experienced fabricator(s), adequate schedule contingency
P. Giannotti	1.9 Infrastructure	Pole Tips delayed	Supplier reports cannot meet schedule	Final Installation (moving detector to IR) delayed	Production	Low	Moderate	Low	Reliable experienced fabricator(s), adequate schedule contingency (pole tips installation near end of installation schedule)
D. Lynch	1.10 Integration & Installation	Subsystem not ready for installation	Subsystem reports cannot meet schedule	Detector Installation Delayed	Production	Moderate	Moderate	Moderat e	Build in adequate schedule contingency
D. Lynch	1.10 Integration & Installation	Engineering Resources not available	Schedule slippage of design efforts prior to commencement of installation	Detector Installation Delayed	Design	Moderate	Moderate	Moderat e	Schedule relies on significant engineering resources not yet fully committed. Get early commitments from contributing groups for timely participation
D. Lynch	1.10 Integration & Installation	Labor not available for installation	schedule slippage during installation	Detector Installation Delayed	Installation	Low	Moderate	Low	Secure more labor support

WBS	Risk Title	Owner	If	Then	Risk Timeframe	Probability of Event (%)	Cost Impact Estimate ($k)			Schedule Impact (months)		
							Optimistic	Most likely	Pessimistic	Optimistic	Most likely	Pessimistic
1.1	Project Management											
R1.01	Coordination of multiple labs: ORNL, ANL and MSU	S. Zimmermann / P. Fallon	If the collaborating institutions can not make the delivery according to agreement	Then we could impact cost, schedule and performance	All	10%	$20	$40	$60	1	2	4
R1.02	Subcontractor protest (excluding detectors)	S. Zimmermann / P. Fallon	If the subcontractor protests contract award decision	Then the schedule may slip as grievances are being reviewed	All	5%	$10	$20	$40	0.5	1	2
R1.03	DOE initiates additional requirements for project management and execution including work environmental rules and regulations	S. Zimmermann / P. Fallon	If DOE requires additional estimations and procedures	Then more working hours will be require to complete these tasks	All	10%	$20	$40	$60	1	2	3
R1.04	Safety Incident	S. Zimmermann / P. Fallon	If there is an injury	Then the project could be impacted	All	5%	$0	$25	$50	0	0.25	0.5
R1.05	Fire	S. Zimmermann / P. Fallon	If there is a significant fire in the lab area	Then it could be hazardous to employees and materials or financial loss to the project	All	2%	$0	$50	$200	0	0.5	2
R1.06	Seismic activity	S. Zimmermann / P. Fallon	If there is a significant seismic event in the Bay Area	Then the Lab could close for sometime and/or damage to equipment, mechanical structures or detectors could happen	All	2%	$10	$35	$70	0	0.25	0.5
R1.07	Departure of Key Personnel	S. Zimmermann / P. Fallon	If key personnel leave GRETA	Then we may lose specific knowledge and experience	All	20%	$40	$80	$160	1	2	4
R1.09	Change control failure	S. Zimmermann	If change control is not effective	Then change could get implemented without proper review and approval	All	5%	$13	$25	$85	0.5	1	3
R1.10	Failure in the accounting system	M. Barry	If accounting doesn't properly report financial activity	Then we may need to use contingency funds to cover the mistake	All	5%	$100	$200	$300	0	1	3

Assumption for Cost and Schedule Estimates	Overview of Risk Handling Plan	Risk Handling Approach	Risk Assessment
Adds no cost because we have float and the MOU specify that the lab is responsible to deliver within budget. However, it will require more costs associated with the interface in the collaboration.	(a) We have MOUs that specify the responsibilities, the technical scope and deliverables, as well the cost and schedule. They also specifies reporting and monitoring strategies and responsibilities; (b) We have periodic meetings and reviews with the remote labs.	Mitigate	LOW
This does not include detector modules, which may be a sole source contract.	(a) Follow procurement regulations for a fair selection process; (b) In case of sole source justification, document appropriately the decision.	Mitigate	LOW
Assumes $20k/month for a person to complete these tasks. This also includes now ES&H procedures in response to incidents in other institutions.	(a) Keep close relationship with DOE representatives with open communication. (b) Follow DOE guidelines to avoid having to repeat work.	Accept	LOW
Cost: Assumes $100k/month to run the MIE: Assume adding additional safety engineer and sharing cost. *Schedule:* M: assumes a one week stand down to conduct a review safety; P: assumes 2 weeks stand down to review safety. Includes incidents in the whole lab.	Everyone has to follow the Lab and GRETA ES&H directives, as described in the LBNL PUB-3000, the GRETA Safety Plan and the Activity Hazard Documents.	Mitigate	LOW
M: assumes damage to some of the electronics and the price of replacement. P: assumes damage to one detector module and it is necessary to send to the vendor to major repair.	Follow LBNL's guidelines for fire safety.	Mitigate	LOW
Cost: Price to run the project per month is $100k/month, and also material damage of O: $10k, M: $10k or P: $20k; *Schedule:* assumes that the lab will be closed for M: 1 week, P: 2 weeks.	Follow guidelines for personnel and equipment safety regarding earthquakes.	Mitigate	LOW
Assumes $20k/month to train new person and overlap with the leaving expert.	(a) Keep good documentation of the work; (b) Have more than one person working on a critical task; (c) Have succession planning.	Mitigate	LOW
Assumes $25k/month for an engineer/scientist FTE. O, M: minor mistake that requires additional documentation or rework, P: assume reordering parts or major rework.	Change control board meets regularly. GRETA has a QA plan in place and has manpower allocated to oversee the execution and implementation of the QA program. GRETA is imbedded in the LBNL QA plan.	Mitigate	LOW

O: Repair can be done at LBNL/MSU, estimate is for 1 month manpower ($25k/month); M or P: Has to go back to the vendor for repair under warranty. Costs are for manpower in the project to perform follow-up acceptance tests. P: Includes detector rework also under warranty and travel for FAT.	(a) Make sure that the vendor understands the requirements; (b) Work vendor to have make sure their tests detects any possible problem with the detector module; (c) Have Factory Acceptance Tests (FAT).	Mitigate	LOW
This may delay CD4 (GRETA completion), and the project will have to continue running at a cost of ~$160k/year.	(a) Plan schedule, including adequate funding contingency, to accommodate project extension, (b) Include float on the schedule based on experience.	Mitigate	MODERATE
O: 10% underestimated, M: 25% and P: 100% underestimated.	(a) Advance contract preparation, negotiation; (b) Request for the vendor to justify the cost.	Accept	MODERATE
O: 0% net change on exchange rate per year, M: 5%, P: 10% Based on past behavior of the Euro, value accounted for outside this risk registry.	(a) Order detectors as early as possible to retire this risk; (b) If exchange rate is too high, use contingency; (c) In addition, use contingency of other WBS's; (d) In addition, use scope contingency.	Accept	HIGH
O.: Module is repaired at LBNL, simple failure. Cost is manpower only. ML: Send module to the vendor, refurbish 1 crystals, at expanse of $100k/repair plus Project effort; P.: Send module to the vendor, replace 1 crystals.	(a) Follow the manufacturer procedures described in the user manual; (b) Handle the detector with care; (c) If possible, procure spare capsule and replace it at LBNL.	Mitigate	LOW
O: Small damage can be repair at LBNL. M: More extensive requires repair at the vendor and a new crystal ($300k expense); P: Cost of new detector module.	(a) There are written procedures on how to handle the detector; (b) Only trained personnel can execute handling tasks; (c) Mounting tools shall be surveyed to handle the loads; (d) reduce handling; (e) use reputable companies for transportation.	Mitigate	LOW
O: Vendor recovers production capability within 6 months. ML: Vendor recovers within 1 year. Project contributions to recovery. P: Vendor recovers within 1.5 years. Project contributes to recovery.	(a) Close communication with the vendor for notice as early as possible of any potential problems.	Accept	MOD
The price increases by 50% when O: 2 more detectors are needed ML: 8 detectors are needed P: 12 more detectors are needed.	(a) Work closely with the vendor to anticipate such a scenario; (b) Coordinate closely with the community (AGATA, RIKEN); (c) Continue to explore developments of other vendors.	Accept	MOD
No Cost Contingency allocated to handle this risk, just Scope Contingency: O: A new vendor can be found, and 2 prototype phases ($1.5M and 18 months each) bring them up to speed to produce the remaining detectors. M, P: no other vendor can be found to produce the remaining GRETA modules. The project must be de-scoped.	(a) Work closely with the vendor to anticipate such a scenario; (b) Coordinate closely with the community (AGATA, RIKEN); (c) Continue to explore developments of other vendors; (d) If this event happens the project needs to be reevaluated (depending on the phase this event occurs); (e) May need to use Scope Contingency.	Accept	HIGH
$15k/month additional effort, O: delay and effort, M: delay, effort and some materials a required; P: delay, effort and replace ADC and extensive redesign with new prototype	(a) Use accepted design rules; (b) Follow the recommendations of the vendors; (c) Extensive testing of ADC and prototype; (d) Clear list of requirements	Mitigate	MODERATE
O: Compatible substitute parts are available, M: Footprint changes required to accommodate substitute parts, P: Design changes required to accommodate substitute parts	(a) Use electronics components which are produced by several vendors; (b) Avoid components that are going to be discontinued. (c) if a selected component is near the end of life, then we will buy a lifetime quantity	Mitigate	LOW
O: Problem is solved with redesign of cooling, M: Requires re-design of cooling and circuit board, P: move digitizer to crates: requires crates, new connectors, racks, new prototype etc	(a) Evaluate the required temperature stability as early as posible (b) consult with mechanical engineers for ways to increase stability; (c) Use external to the ADCs and stable voltage references; (d) Prototype	Mitigate	LOW
O: shielding can easily be added to existing design, M: A layout change is required to accommodate better decoupling or shielding, P: A redesign is required to change components	(a) Follow good design practice; (b) During the design phase allow for more schielding to be added; (c) Prototype	Mitigate	LOW
O: shielding can easily be added to existing design, M: A layout change is required to accommodate better decoupling or shielding, P: A redesign is required to change components	(a) Follow good design practice; (b) During the design phase allow for more schielding to be added; (c) Prototype	Mitigate	LOW
O: Only simple debugging and rework required (resistors, capacitors, amplifiers, etc.); M: more advanced debugging and rework required (FPGA, etc.), P: Additional production because not enough boards are repairable	(a) Use vendors with good reputation; (b) Qualify vendor(s) during prototype phase; (c) Validate first article before full production. (d) Contract board testing to an outside vendor	Mitigate	MODERATE
O: Installing a higher capacity cooling system is enough; M: A higher capacity cooling system and some redesign; P: Place digitizer in crates;	(a) Evaluate ADC Module performance early; (b) Consult with mechanical engineers about cooling limits; (c) Prototype	Mitigate	MODERATE
O: 1 Month extra work; M: 2 month extra work; P: 4 month extra work; $25k per month	(a) Reevaluate the impact on design time as requirements are written; (b) Use experience from GRETINA implementation; (c) Prototype system	Mitigate	LOW
O: A component with spare on hand beaks and needs swapping, M: An off the shelf component fails and needs to be purchased, P: A custom component fails and needs fabrication	(a) Minimize the use of custom parts; (b) Backup all programs and source; (c) Have spares for likely to fail items; (d) Have spares for low cost items	Mitigate	LOW
Work done by two people: O: half a month extra work; M: 1 month extra work; P: 2 months of extra work to make up for miscommunication	(a) Have the institutions agree on their responsibilities; (b) Document interfaces well and clarify ambiguities as they are discovered; (c) Review documents together; (d) Encourage communication between the teams	Mitigate	LOW